Space Weather Technical Forecast

Issued on Friday, 30 September 2022 at 13:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1-G2/Minor-Moderate geomagnetic storms expected day 1 until day 3. Chance of G3/Strong storm from CME arrival day 2. M-class flares considered Likely. Active electron fluence likely by day 4.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with a single M1 flare at 30/0401 UTC, which appears to have originated from the northeast limb, close to the NEW region which has recently rotated into view. This region is the source of several CME's over recent days and is expected to the be the most active region on the disk in coming days. There are currently four numbered sunspots on the visible disc, all of which are either stable or gradually decaying. Out of these four, only AR3110 and AR3007 show any sign of moderate size or complexity.

Solar Wind / Geomagnetic Activity: Solar wind parameters were indicative of continued high speed stream influence, with an embedded transient. Solar wind speeds, as measured by DSCOVR at L1, were on a declining trend from elevated to slightly elevated before briefly peaking around 600 km/s around 30/0600 UTC. The density was generally around average or slightly above. The total Interplanetary magnetic field strength, Bt, started weak, then became moderate after 30/0430 UTC, reaching a maximum of 15nT. The north-south component, Bz, was weak initially, then increased after 30/0430 UTC with increasing periods in the negative orientation, fluctuating between +7/-9nT. The phi angle was mostly positive (away from the Sun) with brief periods at negative (toward the sun). Geomagnetic activity during 29th was Quiet (Kp 0 to 2), then became Unsettled to Active (Kp 3-4) during 30th.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, was at or near background levels. High energy electron flux (greater than 2 MeV) was at background levels. The associated 24-hour fluence remained below the Active (1e8 integrated pfu) threshold. Observed fluence at 30/0000UTC was 1.11e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Moderate with isolated M-class flares considered likely.

Solar Wind / Geomagnetic Activity: The CME from the filament eruption on 28/0400 UTC has the potential to move across Earth day 2 (1st). Solar winds are expected to be elevated, on a slight declining trend at first, before the next coronal hole high speed stream (HSS) from CH27/+ arrives later day 1 (30th), and another HSS arrives from CH28/+ later day 2 (1st). The HSS influence is expected to persist through days 3 and 4 (2nd and 3rd). Unsettled to Active (Kp 3-4) intervals are expected at first, with an increase later today to G1/Minor to G2/Moderate storm levels (Kp 5-6). Activity levels may increase further tomorrow from any CME arrival, with a chance of an isolated G3/Strong Storm (Kp 7) interval. Activity easing to Quiet to Unsettled (Kp 2-3) by late day 4 (3rd).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is

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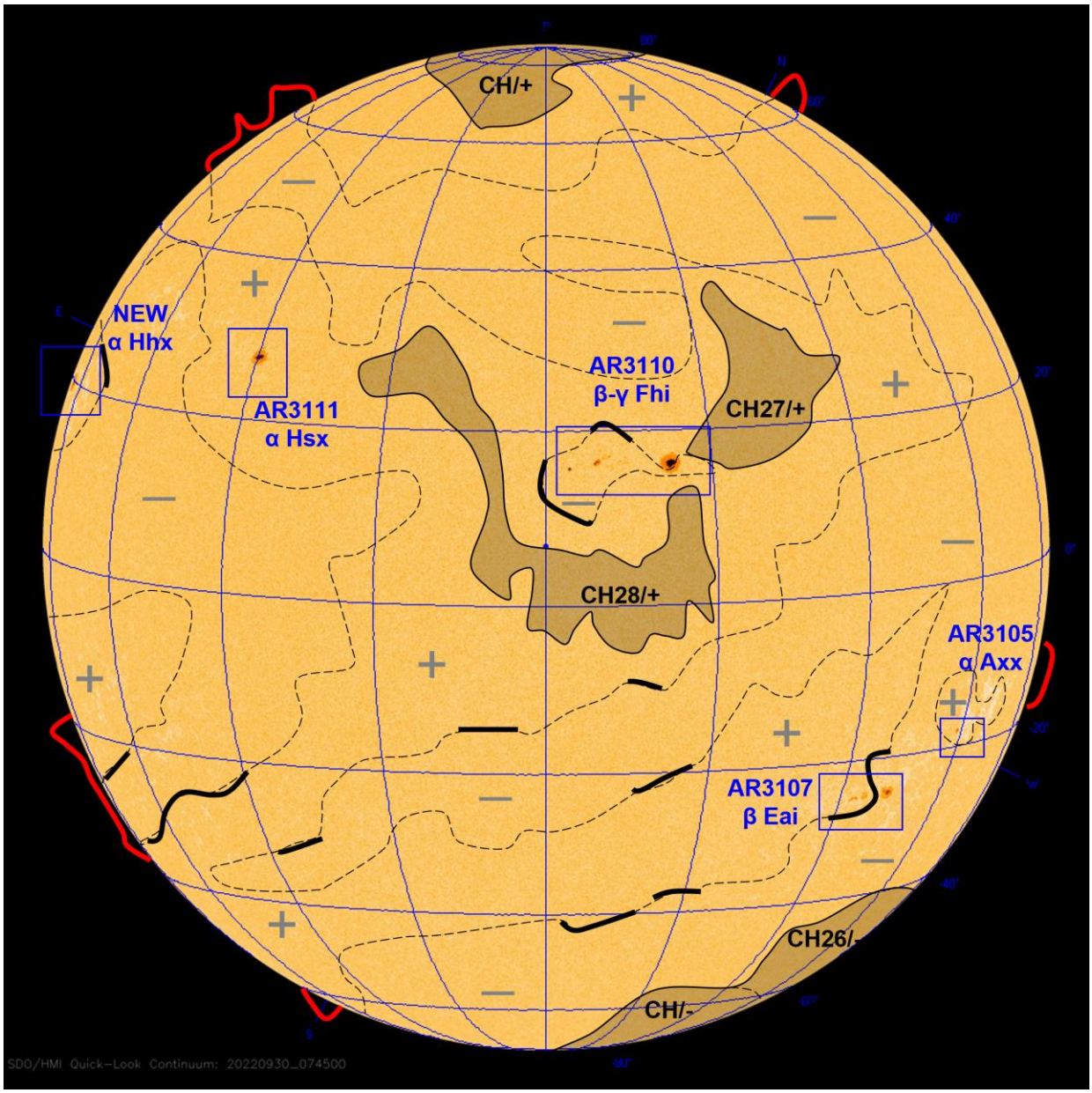
expected to remain at or close to background levels. The high energy (greater than 2MeV) electron flux will likely remain at mostly background initially, but likely rising to exceed High (1000 pfu) levels at times during days 3 and 4 (2nd and 3rd) . However, there is some uncertainty due to the potential CME arrival tomorrow (1st), with any associated geomagnetic activity possibly offsetting the influence of the two HSS. The associated 24 hour fluence is likely to rise in response, and may exceed the Active (1e8 integrated flux) threshold later day 4 (3rd).

Figure 1. Solar Analysis Valid 30/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME from a filament eruption to the southwest of AR3110 around 28/0400 UTC has the potential to arrive at Earth day 2 (1st). However this has a low confidence analysis due to the lack of STEREO A imagery, combined with low confidence in background winds in the current Enlil model.

Solar winds are currently elevated and on a slight decline. The next HSS enhancements are expected to become geoeffective later day 1 and through day 2, then persisting through the rest of the forecast period. These next enhancements are due to recurrent CH27/+ and CH28/+ which brought an extended period of Minor to Moderate geomagnetic storming on the last rotation (Kp 5-6). Similar activity is considered likely on this occasion, especially as the autumn equinox has recently occurred. There is some uncertainty though due to Enlil suggesting a slower arrival of the HSS influence, and Stereo A data, although patchy, currently shows little influence from either Coronal Hole. Solar winds are still expected to rise, with a peak of 600-700km/s on the arrival of either CH27/+ of CH28/+.

Unsettled to Active (Kp 3-4) intervals are expected at first, with an increase later today to G1/Minor to G2/Moderate storm levels (Kp 5-6). Activity levels may increase further tomorrow from any CME arrival, with a chance of an isolated G3/Strong Storm (Kp 7) interval. Activity easing to Quiet to Unsettled (Kp 2-3) by late day 4 (3rd)

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	80	80	70	30
Strong	G3	No	20	30	10	1
Severe	G4	No	1	5	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
28/0856	Partial	Filament eruption	NE Quadrant	810 km/s	01/1000 +/-10 hours	Likely imbedded in HSS. Low confidence.

Figure 2: ENLIL shoing CME arrival, though HSS forecast can't be trusted.

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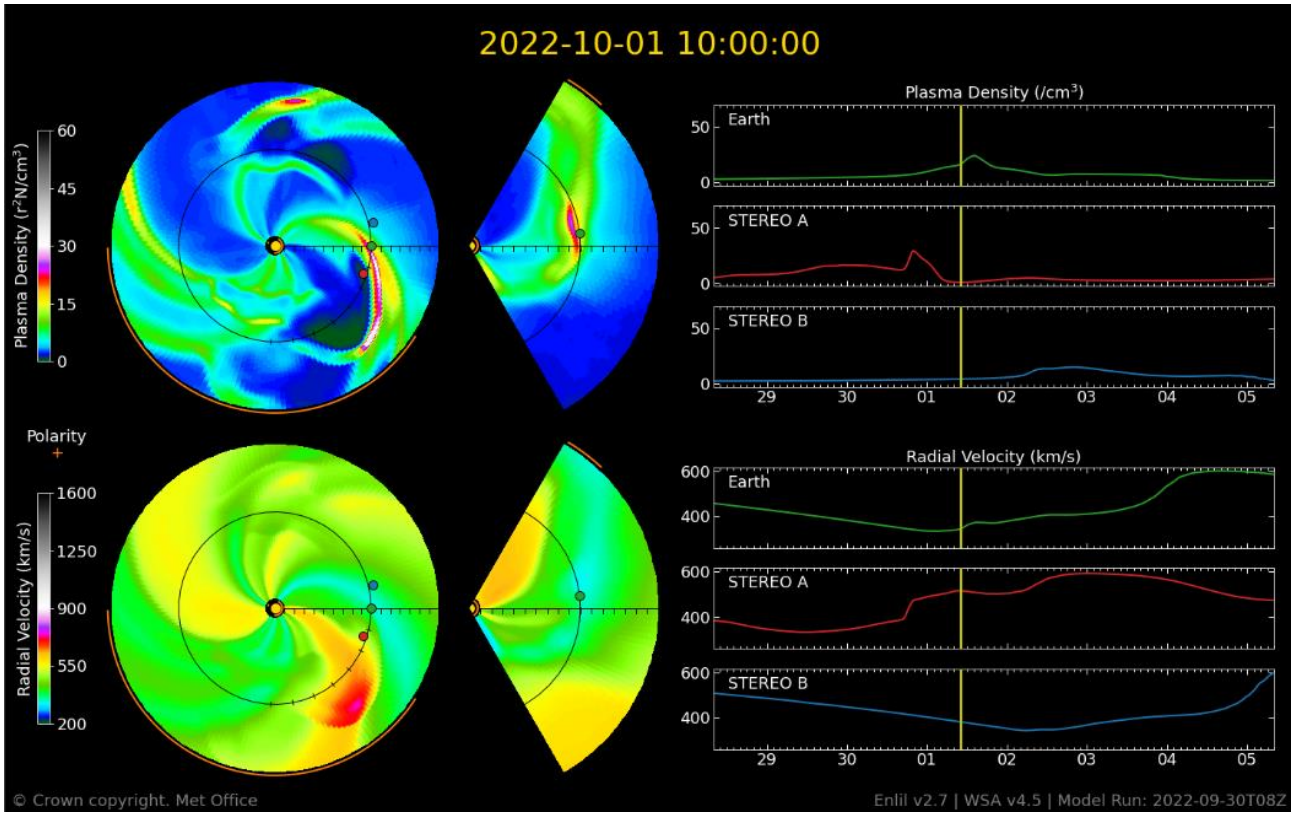

Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate with a single M-class flare at 30/0401 UTC. Further isolated M-class flares are considered likely, mainly due to the New region in the northeast, but also combined with a risk from AR3110.

There are currently four numbered and one unnumbered sunspot regions on the visible disc. The likely largest and most active region seems to be the new region that is currently rotating onto the northeast of the disk. This spot is yet to be numbered, and we are likely only seeing the leading portion of this spot, perhaps with a long trailing portion yet to rotate into view. AR3110 close to centre disk in the north is currently the longest and most magnetically complex of the numbered spots. It has recently developed rudimentary penumbra in it's trailing portion, therefore now reclassified as a 'F' Class spot. AR3107 in the southwest is the next most complex spot but is showing signs of continual decay. AR3111 and AR3105 both remain simple uni-polar spots.

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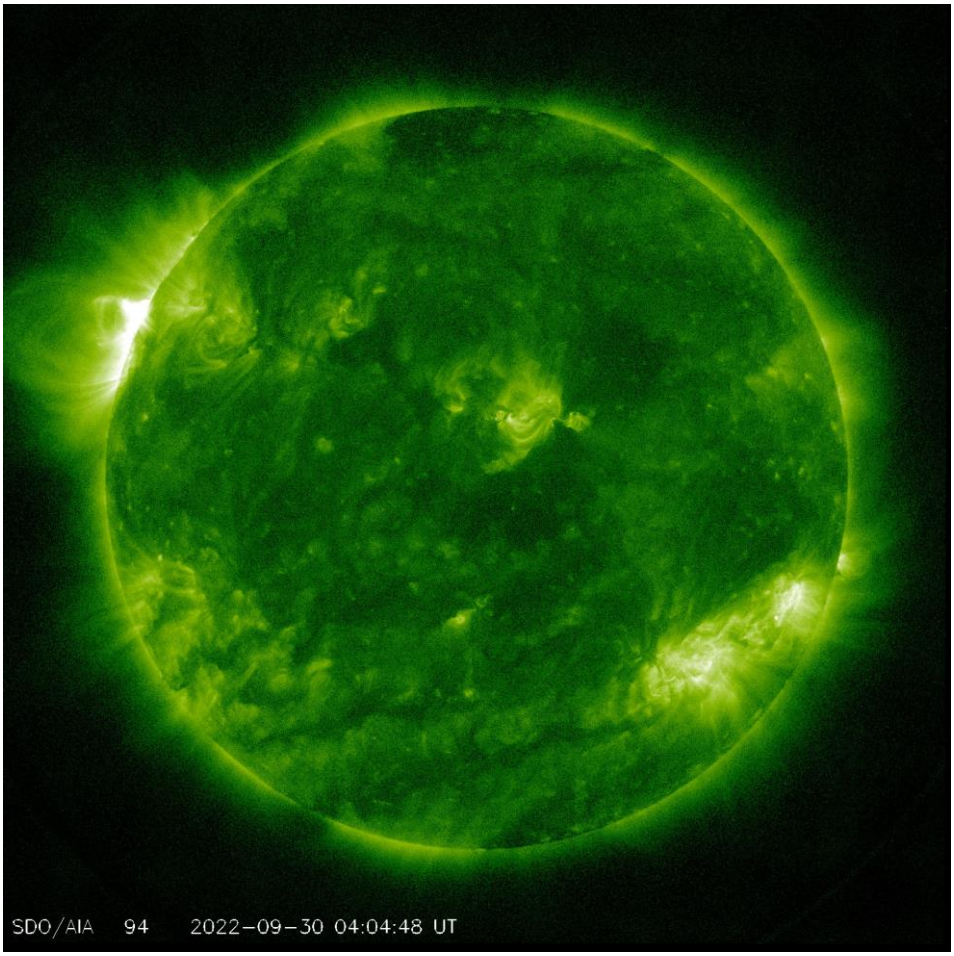
X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: SDO EUV Imagery showing M1 Flare around 0401 UTC on 30th.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16 has declined from very slightly elevated levels to near background. While AR3107 and AR3110 move into an increasingly geoeffective location for proton events, there is only a very slightly above background level chance of these regions producing proton rich flares.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2MeV) electron flux, as observed by GOES-16 has been largely at background levels. The next significant rise in high energy electrons is anticipated to be once the fast winds from CH27/+ and CH28/+ become established, most likely through days 3 and 4. However, building electron counts will be complicated by the potential CME arrival tomorrow (1st Oct). Further geomagnetic enhancements from a CME arrival would help to supress high electron flux levels. and therefore peak values of over 10000 pfu may not occur until day 4 (3rd).

The associated electron 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold until at least day 4 (3rd), while on a generally increasing trend. The REFM is currently over-estimating fluence values, which does not aid confidence in the fluence rising above the Active threshold by late day 3 (2nd). Instead a potential rise in the fluence to breach the Active threshold is preferred for day 4.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	20	40	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	2

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